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Woo et al.

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(54) **IMAGE FORMING APPARATUS HAVING DEVELOPING UNIT**

(71) Applicant: **Samsung Electronics Co., Ltd.**, Suwon-si (KR)

(72) Inventors: **Sang Bum Woo**, Yongin-si (KR); **Sung Dae Kim**, Suwon-si (KR); **Soo Yong Kim**, Suwon-si (KR)

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-Si (KR)

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(52) **U.S. Cl.**
CPC ***G03G 15/1605*** (2013.01); ***G03G 15/1685*** (2013.01); *G03G 15/5058* (2013.01)

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See application file for complete search history.

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Primary Examiner — Joseph S Wong
(74) *Attorney, Agent, or Firm* — Staas & Halsey LLP

(57) **ABSTRACT**

Disclosed herein is an image forming apparatus that has a developing unit, an intermediate transfer body, and a transfer roller and may prevent contamination of the transfer roller and a printing medium by the toner remaining in a test pattern forming area of the intermediate transfer body. The image forming apparatus includes a developing unit to allow an image to be formed by a developing agent, an intermediate transfer body provided with an image forming area and a test pattern forming area, the image being transferred from the developing unit to the image forming area and the test pattern forming area, and a transfer roller allowing the image to be transferred from the image forming area to a printing medium, wherein a maximum transfer length of the transfer roller is less than a maximum image forming length of the developing unit.

14 Claims, 7 Drawing Sheets

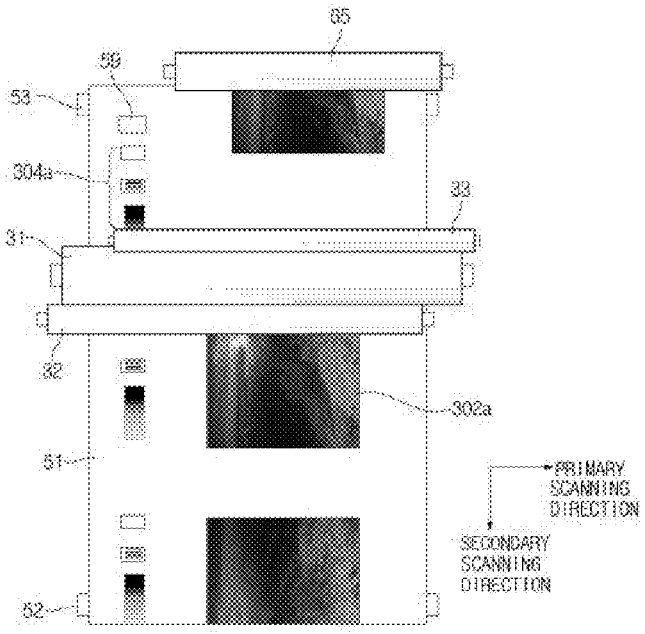

FIG. 1

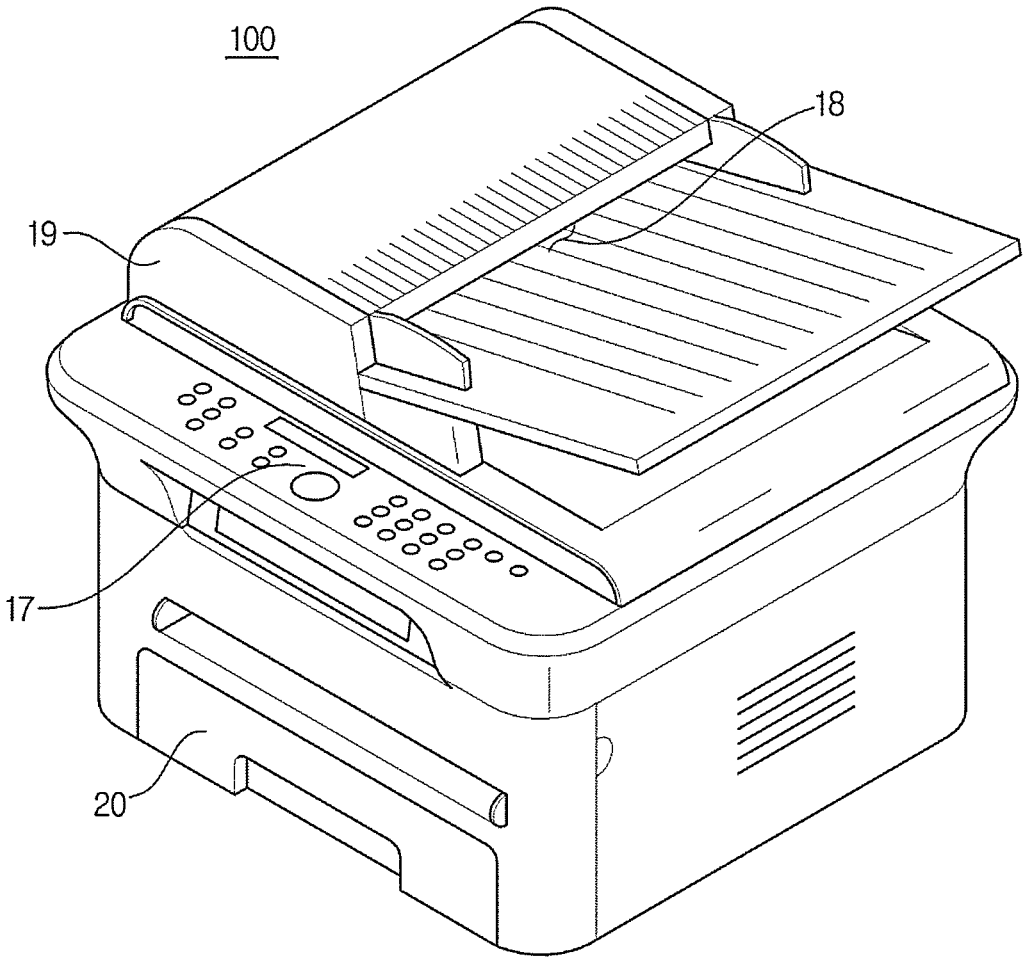

FIG. 2

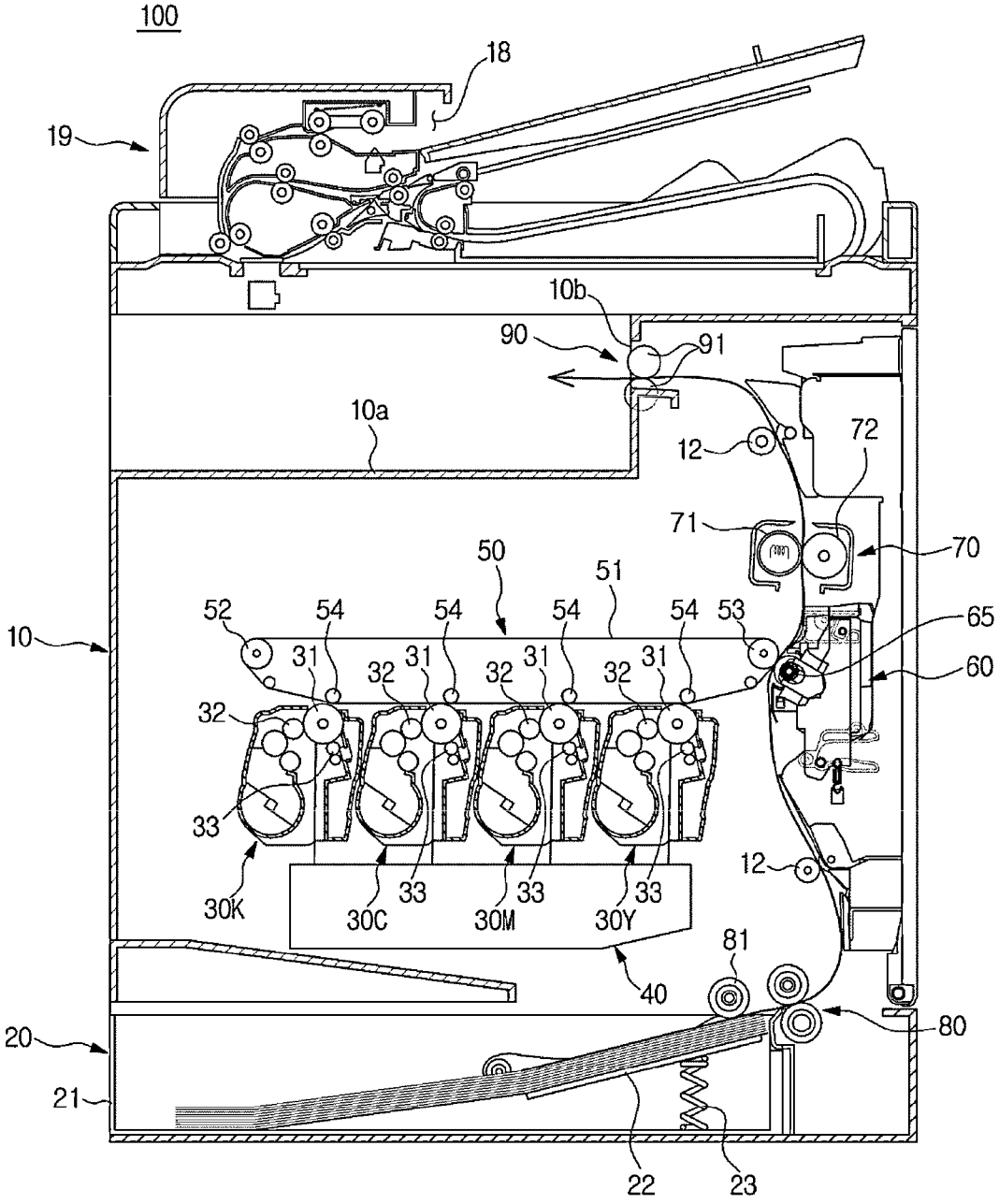
100
18
19
10b
90
91
10a
12
72
71
70
50
51
52
54
53
65
60
10
31
32
33
30K
30C
30M
30Y
40
81
80
20
21
22
23

FIG. 3

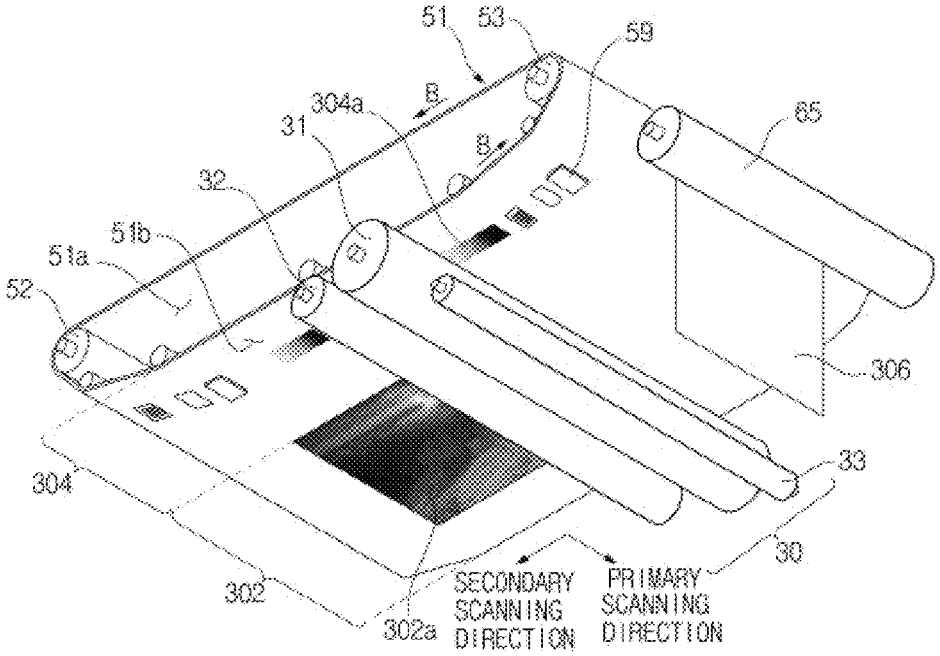
51
53
59
65
304a
31
32
51b
51a
52
306
33
304
30
302
302a
SECONDARY SCANNING DIRECTION
PRIMARY SCANNING DIRECTION

FIG. 4

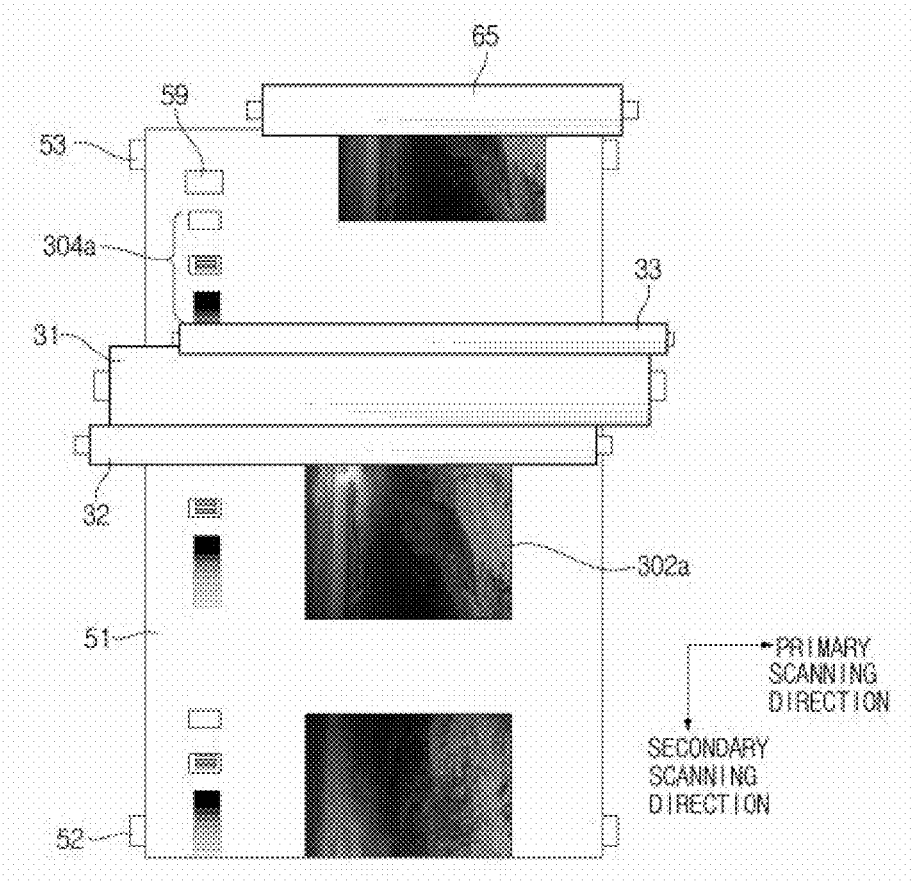
65
59
53
304a
33
31
32
302a
51
PRIMARY SCANNING DIRECTION
SECONDARY SCANNING DIRECTION
52

FIG.5A

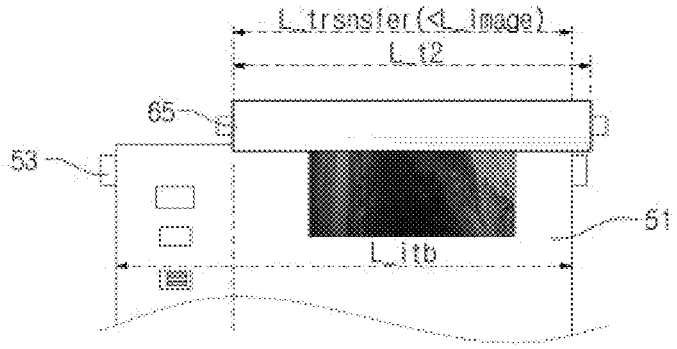
L_trsnsfer(<L_image)
L_t2
65
53
51
L_ltb

FIG.5B

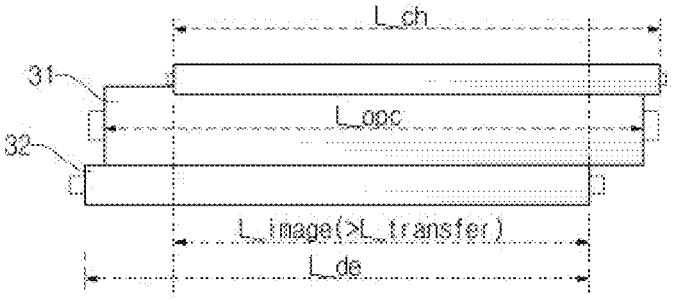
L_ch
31
L_opc
32
L_image(>L_transfer)
L_de

FIG. 6

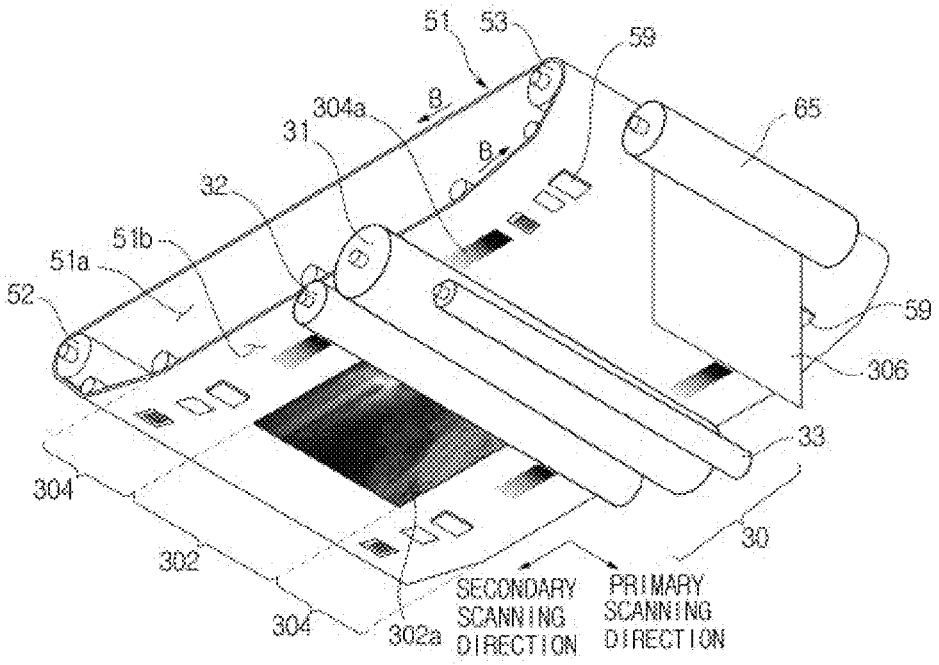
51
53
59
65
304a
B
31
B
32
51b
51a
52
59
306
33
304
30
302
304
302a
SECONDARY SCANNING DIRECTION
PRIMARY SCANNING DIRECTION

FIG. 7

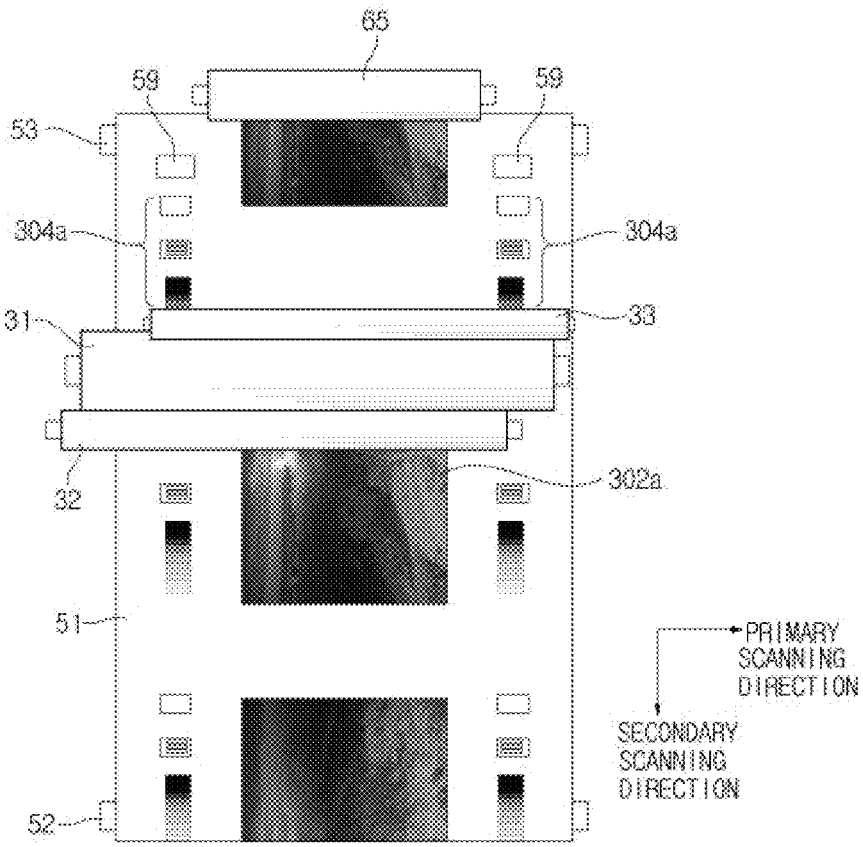
65
59
59
53
304a
304a
31
33
32
302a
51
PRIMARY SCANNING DIRECTION
SECONDARY SCANNING DIRECTION
52

IMAGE FORMING APPARATUS HAVING DEVELOPING UNIT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the priority benefit of Korean Patent Application No. 10-2013-0057594, filed on May 22, 2013 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND

1. Field

Embodiments to an image forming apparatus having a developing unit, an intermediate transfer body, and a transfer roller.

2. Description of the Related Art

In an image forming apparatus having a developing unit, an intermediate transfer body, and a transfer roller, a transfer roller is used to transfer toner transferred to the intermediate transfer body to a printing medium. That is, when a printing medium passes through a gap between the intermediate transfer body and the transfer roller, the transfer roller transfers the toner transferred to the intermediate transfer body to the printing medium. The transfer roller contacts the intermediate transfer body, forming a nip. A separate test pattern is transferred to the intermediate transfer body to conduct color registration or adjustment of color tone. Some of the toner used to form the test pattern often remains on the intermediate transfer body even after removing of the toner is performed.

While no printing medium enters the gap between the intermediate transfer body and the transfer roller, the toner remaining in the test pattern forming area of the intermediate transfer body may contaminate the transfer roller. The contaminated transfer roller may in turn contaminate the rear surfaces of subsequent printing media entering the space between the intermediate transfer body and the transfer roller to allow printing thereon.

SUMMARY

In an aspect of one or more embodiments, there is provided an image forming apparatus that has a developing unit, an intermediate transfer body, and a transfer roller and may prevent contamination of the transfer roller and a printing medium by the toner remaining in a test pattern forming area of the intermediate transfer body.

In an aspect of one or more embodiments, there is provided an image forming apparatus which includes a developing unit to form an electrostatic latent image and allow an image to be formed by a developing agent supplied to the electrostatic latent image, an intermediate transfer body having an image forming area and a test pattern forming area arranged in parallel in a primary scanning direction, wherein the image is transferred from the developing unit to the image forming area and the test pattern forming area, and a transfer roller allowing the image transferred to the image forming area of the intermediate transfer body to be transferred to a printing medium, wherein a maximum transfer length, which may be a maximum length of the transfer roller allowing transfer of the image to the printing medium, is less than a maximum image forming length, which may be a maximum length of the developing unit allowing the image to be developed, wherein the transfer roller may be positioned so that the maximum transfer length of the transfer roller corresponds to the image forming area of the intermediate transfer body, which may be outside of the test pattern forming area of the intermediate transfer body.

The developing unit may include a photosensitive medium, a developing roller, and a charging roller, wherein portions of the photosensitive medium, developing roller, and charging roller overlap each other in the primary scanning direction which may correspond to the maximum image forming length.

The maximum image forming length may include a length of the test pattern forming area and a length of the image forming area.

The maximum transfer length of the transfer roller may be greater than a length in the primary scanning direction of a printing medium with the largest size supported by the image forming apparatus.

A cleaning unit to clean only a test pattern formed in the test pattern forming area may be installed at a position corresponding to the test pattern forming area in the image forming apparatus.

The intermediate transfer body may be a transfer belt.

The intermediate transfer body may be a transfer drum.

In an aspect of one or more embodiments, there is provided an image forming apparatus which includes a developing unit to form an electrostatic latent image and allow an image to be formed by a developing agent supplied to the electrostatic latent image, an intermediate transfer body having an image forming area and two test pattern forming areas arranged at both sides of the image forming area to be parallel with the image forming area in a primary scanning direction, wherein the image is transferred from the developing unit to the image forming area and the two test pattern forming areas, wherein the two test pattern forming areas may include a first test pattern forming area formed on one side of the image forming area and a second test pattern forming area formed on the other side of the image forming area; and a transfer roller allowing the image transferred to the image forming area of the intermediate transfer body to be transferred to a printing medium, wherein a maximum transfer length, which may be a maximum length of the transfer roller allowing transfer of the image to the printing medium is less than a maximum image forming length, which may be a maximum length of the developing unit allowing the image to be developed, wherein the transfer roller may be positioned so that the maximum transfer length of the transfer roller corresponds to the image forming area of the intermediate transfer which may be outside of the two test pattern forming areas of the intermediate transfer body.

The developing unit may include a photosensitive medium, a developing roller, and a charging roller, wherein portions of the photosensitive medium, developing roller, and charging roller overlap each other in the primary scanning direction which may correspond to the maximum image forming length.

The maximum image forming length may include lengths of the two test pattern forming areas and a length of the image forming area.

The maximum transfer length of the transfer roller may be greater than a length in the primary scanning direction of a printing medium with the largest size supported by the image forming apparatus.

A cleaning unit to clean only a test pattern formed in the test pattern forming area may be installed at a position corresponding to the test pattern forming area.

Two cleaning units to clean only test patterns formed in the two test pattern forming areas may be installed at positions corresponding to the two test pattern forming areas in the image forming apparatus.

The intermediate transfer body may be a transfer belt.

The intermediate transfer body may be a transfer drum.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a view illustrating an image forming apparatus according to an exemplary embodiment;

FIG. **2** is a view illustrating an internal structure of an image forming apparatus according to an exemplary embodiment;

FIG. **3** is a view illustrating structures of a transfer belt and a developing unit of an image forming apparatus according to an exemplary embodiment;

FIG. **4** is a plan view illustrating the transfer belt and the developing unit shown in FIG. **3**;

FIGS. **5**A and **5**B are views illustrating a relationship between the lengths of the transfer roller and photosensitive medium, the developing roller, and the charging roller and the length of the transfer belt in the primary scanning direction (i.e., the width of the transfer belt);

FIG. **6** is a view illustrating structures of a transfer belt and a developing unit of an image forming apparatus according to embodiment; and

FIG. **7** is a plan view illustrating the transfer belt and the developing unit shown in FIG. **6**.

DETAILED DESCRIPTION

Reference will now be made in detail to embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

FIG. **1** is a view illustrating an image forming apparatus according to an exemplary embodiment. As shown in FIG. **1**, an automatic document feeder **19** is arranged at the upper portion of the image forming apparatus **100**. The automatic document feeder **19** includes a feed unit **18** and a discharge unit **10***b* (see FIG. **2**). A document (generally, a sheet of paper containing records) to be copied or scanned is inserted into the feed unit **18**. The document inserted into the feed unit **18** undergoes a series of automatic transport processes in the image forming apparatus **100**. Then, the document is scanned and discharged through the discharge unit **10***b* and stacked. The automatic document feeder **19** is installed such that it is openable. When the automatic document feeder **19** is opened (i.e., lifted up), sheets of the document may be manually fed one by one. A control panel is arranged on one surface of the image forming apparatus **100**. The control panel **17** is provided with a keypad, buttons to switch power on/off, a navigation dial for manipulation of menu items, and a display. A cassette **20** to feed printing media is arranged on the front surface of the image forming apparatus **100**. Plural printing media (generally, blank sheets of paper containing no recorded content) may be stacked on the cassette **20**. A printing medium containing recorded content as a resultant of print or copy is discharged through the discharge unit **10***b* disclosed above. In the case of a laser printer shown in FIG. **1** as an example of the image forming apparatus, a series of operations including feeding, transferring, fusing, and discharging of the printing medium are performed in the image forming apparatus **100** to record specific content on the printing medium.

FIG. **2** is a view illustrating an internal structure of an image forming apparatus according to one embodiment. The image forming apparatus **100** includes a body **10** forming an external appearance of the image forming apparatus **100**, a cassette **20** allowing printing media to be stacked thereon, a plurality of developing units **30**C, **30**M, **30**Y and **30**K to turn an electrostatic latent image into a visible image using developing agents (e.g., toner) according to colors, an exposure unit **40** to emit light onto photosensitive media **31** of the developing units **30**C, **30**M, **30**Y and **30**K in a charged state and form an electrostatic latent image on each of the photosensitive media **31**, a transfer device **50** to receive a printing medium from the cassette **20** and transfer a visible image formed on each of the photosensitive media **31** to the printing medium, and a fusing unit **70** to fuse, to the printing medium, the developing agent of the visible image transferred to the printing medium.

The body **10** is provided, at a top thereof, with a stacking section **10***a*, on which a printing medium having an image formed thereon is stacked. The stacking section **10***a* is provided, at one side thereof, with a discharge port **10***b*, through which the printing medium having an image formed thereon is discharged.

The cassette **20** includes a tray **21** movably installed in the body **10**, a knock-up plate **22** disposed in the tray **21** and allowing printing media to be stacked thereon, and an elastic member **23** to elastically support the knock-up plate **22**.

Each of the developing units **30**C, **30**M, **30**Y and **30**K includes a respective photosensitive medium **31**. An electrostatic latent image is formed on a charged surface of the photosensitive medium **31** by the exposure unit **40**. Each of the developing units **30**C, **30**M, **30**Y and **30**K also includes a developing roller **32** to supply a developing agent to the photosensitive medium **31**, and a charging roller **33** to charge the surface of the photosensitive medium **31**.

In an embodiment, the developing units **30**C, **30**M, **30**Y and **30**K include four developing units **30**C, **30**M, **30**Y and **30**K, each of which stores one of the developing agents of cyan (C), magenta (M), yellow (Y) and black (K) colors to develop an image in cyan (C), magenta (M), yellow (Y) and black (K) colors. The four developing units **30**C, **30**M, **30**Y and **30**K are disposed in parallel at the lower side of the transfer devices **50** and **60**.

The exposure unit **40** emits light carrying image information onto the photosensitive media **31** provided to the respective developing units **30**C, **30**M, **30**Y and **30**K, forming an electrostatic latent image on the surface of the respective photosensitive media **31**.

The transfer devices **50** and **60** include a first transfer unit **50**, to which visible images formed on the developing units **30**C, **30**M, **30**Y and **30**K by the developing agents are transferred, and a second transfer unit **60** to transfer a visible image on the first transfer unit **50** to a printing medium. The second transfer unit **60** includes a transfer roller **65**.

The fusing unit **70** includes a heating roller **71** to generate heat, and a pressing roller **72** having an outer circumferential surface made of an elastically deformable material and adapted to press the printing medium against an outer circumferential surface of the heating roller **71**

In addition, the body **10** includes a pick-up unit **80** disposed at the upper portion of the cassette **20** to pick up printing media stacked on the knock-up plate **22** one by one, transport rollers **12** to guide a printing medium picked up by the pick-up unit **80** to an upper side, and a discharge unit **90** disposed at the upper side of the fusing unit **70** and at a portion of the body **10** adjacent to the discharge port **10***b* to allow the printing medium having passed through the fusing unit **70** to be

discharged through the discharge port **10***b*. The pick-up unit **80** includes a pick-up roller **81** to pick up the printing media on the knock-up plate **22** one by one, and the discharge unit **90** includes a pair of discharge rollers **91** disposed inside the discharge port **10***b*.

In the image forming apparatus configured as above, the first transfer unit **50** includes a transfer belt **51** disposed in the body **10**, which is an example of an intermediate transfer body to which the visible images of the developing agents formed on the photosensitive media **31** of the developing units **30**C, **30**M, **30**Y and **30**K are transferred in an overlapping manner, a drive roller **52** and a driven roller **53** disposed at opposite inner sides of the transfer belt **51** to rotate the transfer belt **51**, a plurality of transfer rollers **54** disposed to face the photosensitive media **31** of the respective developing units **30**C, **30**M, **30**Y and **30**K with the transfer belt **51** interposed between each transfer roller **54** and the corresponding photosensitive medium **31** so as to allow visible images formed on the photosensitive media **31** to be transferred to the transfer belt **51**, a transfer belt frame (not shown) at which both sides of each of the rollers **54**, drive roller **52**, and driven roller **53** are rotatably installed. As the intermediate transfer body, a transfer roller may be employed in place of the transfer belt **51**.

FIG. **3** is a view illustrating structures of a transfer belt and a developing unit of an image forming apparatus according to one embodiment. In an embodiment, the image forming apparatus is provided with four developing units **30**C, **30**M, **30**Y and **30**K to implement four colors of cyan (C), magenta (M), yellow (Y) and black (K). However, in FIG. **3**, one developing unit **30** among the four developing units **30**C, **30**M, **30**Y and **30**K is shown as a representative example, and the other three developing units are omitted. In addition, regarding the constituents of the developing unit **30**, the photosensitive medium **31**, developing roller **32**, and charging roller **330** are shown, and the other constituents of the developing unit **30** are omitted.

The configuration of the transfer belt **51** will be first described with reference to FIG. **3**. The transfer belt **51** having the shape of a closed loop is looped over the drive roller **52** and the driven roller **53**, which are spaced apart from each other and fixed, in the form of an open belt such that the transfer belt **51** is tensioned to an extent equal to or greater than a certain extent by the drive roller **52** and the driven roller **53**. The transfer belt **51** runs in a cycle along the outer circumferential surfaces of the drive roller **52** and the driven roller **53** in the direction indicated by arrow B according to rotation of the drive roller **52** and the driven roller **53**. One surface of the transfer belt **51** that contacts the outer circumferential surfaces of the drive roller **52** and the driven roller **53** may be defined as an inner surface **51***a*, and the other surface of the transfer belt **51** that does not contact the drive roller **52** and the driven roller **53** may be defined as the outer surface **51***b*. According to this definition, the outer surface **51***b* of the transfer belt **51** is provided with an image forming area **302** and an auto color registration (ACR) test pattern forming area **304**. The image forming area **302** of the transfer belt **51** is an area where an image to be printed onto a printing medium **306** turns into a visible image **302***a* through a developing agent (e.g., toner). The ACR test pattern forming area **304** is provided in a section of the outer surface **51***b* of the transfer belt **51** next to the image forming area **302** where the visible image **302***a* is not formed. That is, the visible image **302***a* and an ACR test pattern **304***a* are formed in parallel on the outer surface **51***b* of the transfer belt **51** in the primary scanning direction. The ACR test pattern **304***a*, which is a test pattern for color position correction and color density correction, is formed in the ACR test pattern forming area **304** of the transfer belt **51**. The shape, spacing and color of the ACR test patterns **304***a* formed in the ACR test pattern forming area **304** are detected by a test pattern detector **59** and transmitted to the controller (e.g., the CPU) of the image forming apparatus. The test pattern detector **59** includes a light emitting part to emit light to the outer surface **51***b* of the transfer belt **51** and a light receiving part to receive light reflected from the outer surface **51***b* of the transfer belt **51**. The test pattern detector **59**, which is designed to detect the shape, spacing and color of the ACR test patterns **304***a* formed on the outer surface **51***b* of the transfer belt **51**, is installed at a position on the movement trajectory of the transfer belt **51** where the ACR test pattern **304***a* is formed, such that the test pattern detector **59** is spaced apart from the outer surface **51***b* of the transfer belt **51**. The installation position of the test pattern detector **59** as above allows the test pattern detector **59** to detect the shape, spacing and color of the ACR test patterns **304***a* formed in the ACR test pattern forming area **304** of the outer surface **51***b* of the transfer belt **51** while the transfer belt **51** moves.

In addition, the developing unit **30** shown in FIG. **3** is configured as follows. In FIG. **3**, only the photosensitive medium **31**, the developing roller **32** and the charging roller **33** of the developing unit **30** are shown and the other constituents of the developing unit **30** are omitted. The photosensitive medium **31** is rotatably installed and slightly spaced apart from the outer surface **51***b* of the transfer belt **51**. When the visible image **302***a* is formed on the outer surface **51***b* of the image forming area **302** of the transfer belt **51**, or when the ACR test pattern **304***a* is formed in the ACR test pattern forming area **304**, the photosensitive medium **31** moves toward the transfer belt **51** and contacts the outer surface **51***b* of the transfer belt **51** such that the visible image **302***a* is formed. To this end, the developing roller **32** and the charging roller **33** also move to the transfer belt **51** along with the photosensitive medium **31**. However, the developing roller **32** and the charging roller **33** do not contact the outer surface **51***b* of the transfer belt **51**. Accordingly, the developing roller **32** and the charging roller **33** are joined to the photosensitive medium **31** such that the developing roller **32** and the charging roller **33** are father spaced apart from the outer surface **51***b* of the transfer belt **51** than the photosensitive medium **31**.

The transfer roller **65** is rotatably installed at a position adjacent to the driven roller **53**, which supports one end of the transfer belt **51**. That is, during circulating movement of the transfer belt **51**, the transfer belt **51** passes through the gap between the driven roller **53** and the transfer roller **65**. In addition, a printing medium **306** passes through the gap between the outer surface **51***b* of the transfer belt **51** and the transfer roller **65**. The transfer roller **65** causes the visible image **302***a* formed in the image forming area **302** of the transfer belt **51** to be transferred to the surface of the printing medium **306**. That is, while the transfer belt **51** moves in a circulating manner and the printing medium **306** passes through the gap between the transfer belt **51** and the transfer roller **65**, the transfer roller **65** causes the developing agent (e.g., toner) staying in the image forming area **302** of the transfer belt **51** to be transferred to the surface of the printing medium **306**.

FIG. **4** is a plan view illustrating the transfer belt and the developing unit shown in FIG. **3**. Particularly, FIG. **4** shows the transfer belt **51** and the developing unit **30** viewed in the direction perpendicular to the outer surface **51***b* of the transfer belt **51**. In the image forming apparatus according to an embodiment, the photosensitive medium **31**, the developing roller **32**, the charging roller **33**, and the transfer roller **65** are configured to have lengths and installation positions as shown

in FIG. **4** in order to allow the visible image **302***a* and the ACR test pattern **304***a* to be normally formed on the outer surface **51***b* of the transfer belt **51** and to prevent contamination of the transfer roller **65** by the ACR test pattern **304***a*. In this configuration, a cleaning unit (not shown) to remove the ACR test pattern **304***a* is needed, but a cleaning unit to prevent contamination of the transfer roller **65** by the visible image **302***a* is not needed.

As shown in FIG. **4**, the visible image **302***a* and the ACR test pattern **304***a* are formed in parallel on the outer surface **51***b* of the transfer belt **51** and laterally separated from each other in the primary scanning direction. In an embodiment, the visible image **302***a* formed on the transfer belt **51** directly contacts the transfer roller **65** without assistance of a separate cleaning unit (not shown). During the printing operation, the printing medium **306** passes through the gap between the transfer belt **51** and the transfer roller **65**. Accordingly, the visible image **302***a* formed on the outer surface **51***b* of the transfer belt **51** is normally transferred to the printing medium **306**, and thus the transfer roller **65** is not contaminated. In addition, the ACR test pattern **304***a* does not contact the transfer roller **65**. Accordingly, even if the ACR test pattern **304***a* is not cleaned, the ACR test pattern **304***a* passes through the transfer roller **65** without contaminating the transfer roller **65** after being detected by the test pattern detector **59**. Then, the ACR test pattern **304***a* is cleaned and removed from the transfer belt **51** by the cleaning unit (not shown) before another ACR test pattern is formed.

FIGS. **5**A and **5**B are views illustrating a relationship of the lengths of the transfer roller, photosensitive medium, developing roller, and charging roller to the length of the transfer belt in the primary scanning direction (i.e., the width of the transfer belt). The term "length" referred to in the following description denotes the length of the transfer belt **51** in the primary scanning direction. If the length needs to be defined in a direction other than the primary scanning direction of the transfer belt **51**, the length will be defined otherwise.

FIG. **5**A illustrates a relation of the length of the transfer roller **65** to the length of the transfer belt **51** in the primary scanning direction (i.e., the width of the transfer belt **51**). As shown in FIG. **5**A, the maximum transfer length L_transfer allowing transfer of the developing agent to the printing medium **306** corresponds to the overlapping portions of the transfer roller **65** and the transfer belt **51**. The developing agent (e.g., toner) is not transferred to the printing medium **306** through the portion of the transfer belt **51** which does not overlap the transfer roller **65**. The maximum transfer length L_transfer is equal to the length of the image forming area **302** (the length in the primary scanning direction). Herein, contamination of the transfer roller **65** by the ACR test pattern **304***a* does not occur only when the maximum transfer length L_transfer is less than the maximum image forming length L_image, which will be described later, and greater than the maximum length of the printing medium **306** in the primary scanning direction (i.e., the lateral width) that is supported by the image forming apparatus.

The maximum image forming length L_image shown in FIG. **5**B is determined by the portions of the photosensitive medium **31**, the developing roller **32** and the charging roller **33** overlapping one another. The maximum image forming length L_image, namely the maximum length of an image developed on the photosensitive medium **31** is the length of the overlapping portion of the charging roller length (L_ch), the photosensitive medium length (L_opc), and the developing roller length (L_de). In a part of the overlapping portion which is exposed to light from a laser scanning unit (not shown), the developing agent (toner) from the developing roller **32** is formed. The maximum image forming length L_image includes both the length of the image forming area **302** in which the visible image **302***a* is formed, and the length of the test pattern area **304** in which the ACR test pattern **304***a* is formed. Of the maximum image forming length L_image, the length (the length in the primary scanning direction) of the image forming area **302** is determined as the maximum length (the lateral width) of the printing medium **306** supported by the image forming apparatus.

How to determine the maximum transfer length L_transfer and the maximum image forming length L_image has been described above with reference to FIGS. **5**A and **5**B. To implement both the visible image **302***a* and the ACR test pattern **304***a* and prevent contamination of the transfer roller **65**, the maximum transfer length L_transfer and the maximum image forming length L_image should satisfy the relation of L_transfer<L_image, and the position where the maximum transfer length L_transfer is formed should be set at the location corresponding to the image forming area **302** out of the test pattern forming area **304**. This is intended to prevent contamination of the transfer roller **65** by the ACR test pattern **304***a* by limiting the length and position of the image forming area **302** where the visible image **302***a* may be formed, specifically by setting the position at a location out of the test pattern forming area **304** since the maximum transfer length L_transfer is involved in forming the visible image **302***a* in the image forming area **302**. In addition, to print an image on the printing medium **306** with the maximum size supported by the image forming apparatus, the maximum transfer length L_transfer needs to be greater than the length in the primary scanning direction (i.e., the lateral width) L_medium of the printing medium **306**. That is, to prevent contamination of the transfer roller **65** and ensure normal printing, the relation of L_medium<L_transfer<L_image should be satisfied.

FIG. **6** is a view illustrating structures of a transfer belt and a developing unit of an image forming apparatus according to an embodiment. In an embodiment, the image forming apparatus is provided with four developing units **30**C, **30**M, **30**Y and **30**K to implement four colors of cyan (C), magenta (M), yellow (Y) and black (K). However, in FIG. **6**, one developing unit **30** among the four developing units **30**C, **30**M, **30**Y and **30**K is shown as a representative example, and the other three developing units are omitted. In addition, regarding the constituents of the developing unit **30**, the photosensitive medium **31**, developing roller **32**, and charging roller **330** are shown, and the other constituents of the developing unit **30** are omitted.

The configuration of the transfer belt **51** will be first described with reference to FIG. **6**. The transfer belt **51** having the shape of a closed loop is looped over the drive roller **52** and the driven roller **53**, which are spaced apart from each other and fixed, in the form of an open belt such that the transfer belt **51** is tensioned to an extent equal to or greater than a certain extent by the drive roller **52** and the driven roller **53**. The transfer belt **51** runs in a cycle along the outer circumferential surfaces of the drive roller **52** and the driven roller **53** in the direction indicated by arrow B according to rotation of the drive roller **52** and the driven roller **53**. One surface of the transfer belt **51** that contacts the outer circumferential surfaces of the drive roller **52** and the driven roller **53** may be defined as an inner surface **51***a*, and the other surface of the transfer belt **51** that does not contact the drive roller **52** and the driven roller **53** may be defined as the outer surface **51***b*. According to this definition, the outer surface **51***b* of the transfer belt **51** is provided with an image forming area **302** and an auto color registration (ACR) test pattern forming area

304. The image forming area 302 positioned at the center of the transfer belt 51 in the primary scanning direction is an area where an image to be printed onto a printing medium 306 turns into a visible image 302*a* through a developing agent (e.g., toner). The ACR test pattern forming area 304 is provided in a section of the outer surface 51*b* of the transfer belt 51 next to the image forming area 302 where the visible image 302*a* is not formed. That is, an ACR test pattern 304*a*, a visible image 302*a* and another ACR test pattern 304*a* are formed in parallel on the outer surface 51*b* of the transfer belt 51 along the primary scanning direction. The ACR test patterns 304*a*, which are test patterns for color position correction and color density correction, are formed in the ACR test pattern forming area 304 of the transfer belt 51. The shape, spacing and color of the ACR test patterns 304*a* formed in the ACR test pattern forming area 304 are detected by test pattern detectors 59 and transmitted to the controller (e.g., the CPU) of the image forming apparatus. Each of the test pattern detectors 59 includes a light emitting part to emit light to the outer surface 51*b* of the transfer belt 51 and a light receiving part to receive light reflected from the outer surface 51*b* of the transfer belt 51. In an embodiment, two test pattern detectors 59, which are designed to detect the shape, spacing and color of the ACR test patterns 304*a* formed on the outer surface 51*b* of the transfer belt 51, are installed at positions on the movement trajectory of the transfer belt 51 where the ACR test patterns 304*a* are formed, such that the test pattern detectors 59 are spaced apart from the outer surface 51*b* of the transfer belt 51. The installation position of the test pattern detectors 59 as above allows the test pattern detector 59 to detect the shape, spacing and color of the ACR test patterns 304*a* formed in the ACR test pattern forming area 304 of the outer surface 51*b* of the transfer belt 51 while the transfer belt 51 moves.

In addition, the developing unit 30 shown in FIG. 6 is configured as follows. In FIG. 6, only the photosensitive medium 31, the developing roller 32 and the charging roller 33 of the developing unit 30 are shown and the other constituents of the developing unit 30 are omitted. The photosensitive medium 31 is rotatably installed and a little spaced apart from the outer surface 51*b* of the transfer belt 51. When the visible image 302*a* is formed on the outer surface 51*b* of the image forming area 302 of the transfer belt 51, or when the ACR test pattern 304*a* is formed in the ACR test pattern forming area 304, the photosensitive medium 31 moves to the transfer belt 51 and contacts the outer surface 51*b* of the transfer belt 51 such that the visible image 302*a* is formed. To this end, the developing roller 32 and the charging roller 33 also move toward the transfer belt 51 along with the photosensitive medium 31. However, the developing roller 32 and the charging roller 33 do not contact the outer surface 51*b* of the transfer belt 51. Accordingly, the developing roller 32 and the charging roller 33 are joined to the photosensitive medium 31 such that the developing roller 32 and the charging roller 33 are father space apart from the outer surface 51*b* of the transfer belt 51 than the photosensitive medium 31.

The transfer roller 65 is rotatably installed at a position adjacent to the driven roller 53, which supports one end of the transfer belt 51. That is, during the circulating movement of the transfer belt 51, the transfer belt 51 passes through the gap between the driven roller 53 and the transfer roller 65. In addition, a printing medium 306 passes through the gap between the outer surface 51*b* of the transfer belt 51 and the transfer roller 65. The transfer roller 65 causes the visible image 302*a* formed in the image forming area 302 of the transfer belt 51 to be transferred to the surface of the printing medium 306. That is, while the transfer belt 51 moves in a circulating manner and the printing medium 306 passes through the gap between the transfer belt 51 and the transfer roller 65, the transfer roller 65 causes the developing agent (e.g., toner) in the image forming area 302 of the transfer belt 51 to be transferred to the surface of the printing medium 306.

FIG. 7 is a plan view illustrating the transfer belt and the developing unit shown in FIG. 6. Particularly, FIG. 7 shows the transfer belt 51 and the developing unit 30 viewed in the direction perpendicular to the outer surface 51*b* of the transfer belt 51. In the image forming apparatus according to an embodiment, the photosensitive medium 31, the developing roller 32, the charging roller 33, and the transfer roller 65 are configured to have lengths and installation positions as shown in FIG. 4 in order to allow the visible image 302*a* and the ACR test patterns 304*a* to be normally formed on the outer surface 51*b* of the transfer belt 51 and to prevent contamination of the transfer roller 65 by the ACR test pattern 304*a*. In this configuration, a cleaning unit (not shown) to remove the ACR test patterns 304*a* is needed, but a cleaning unit to prevent contamination of the transfer roller 65 by the visible image 302*a* is not needed.

As shown in FIG. 7, an ACR test pattern 304*a*, a visible image 302*a* and another ACR test pattern 304*a* are formed in parallel on the outer surface 51*b* of the transfer belt 51 and laterally separated from each other along the primary scanning direction. In an embodiment, the visible image 302*a* formed on the transfer belt 51 directly contacts the transfer roller 65 without assistance of a separate cleaning unit (not shown). During the printing operation, the printing medium 306 passes through the gap between the transfer belt 51 and the transfer roller 65. Accordingly, the visible image 302*a* formed on the outer surface 51*b* of the transfer belt 51 is normally transferred to the printing medium 306, and thus the transfer roller 65 is not contaminated. In addition, the ACR test patterns 304*a* do not contact the transfer roller 65. Accordingly, even if the ACR test pattern 304*a* is not cleaned, the ACR test patterns 304*a* pass through the transfer roller 65 without contaminating the transfer roller 65 after being detected by the test pattern detectors 59. Then, ACR test patterns 304*a* are cleaned and removed from the transfer belt 51 by the cleaning unit (not shown) before another ACR test pattern is formed.

As shown in FIG. 7, the transfer roller 65 is positioned at the center of the transfer belt 51 in the primary scanning direction, and has a length that covers the length of the image forming area 302 but does not reach the test pattern forming area 304. The transfer roller 65 is positioned at the center of the transfer belt 51 in the primary scanning direction since the image forming area 302 is positioned at the center of the transfer belt 51 in the primary scanning direction. In addition, the length of the transfer roller 65 is designed to cover the length of the image forming area 302 but not to reach the test pattern forming area 304, such that the transfer roller 65 is involved in formation of the visible image 302*a* in the image forming area 302, not in formation of the ACR test patterns 304*a* in the test pattern forming area 304, and is not contaminated by the ACR test patterns 304*a*.

The relationship between the lengths of the transfer roller 51, photosensitive medium 31, the developing roller 32, and the charging roller 33 to the length of the transfer belt 51 in the primary scanning direction (i.e., the width of the transfer belt 51) illustrated in FIG. 7 is the same as the relationship of the lengths previously described with reference to FIGS. 5A and 5B. That is, the maximum transfer length L_transfer allowing transfer of the developing agent to the printing medium 306 corresponds to the overlapping portions of the transfer roller 65 and the transfer belt 51. The maximum transfer length

L_transfer is equal to the length (the length in the primary scanning direction) of the image forming area **302**. Herein, contamination of the transfer roller **65** by the ACR test patterns **304***a* does not occur only when the maximum transfer length L_transfer is less than the maximum image forming length L_image.

The maximum image forming length L_image, namely the maximum length of an image developed on the photosensitive medium **31** is the length of the overlapping portion of the charging roller length (L_ch), the photosensitive medium length (L_opc), and the developing roller length (L_de). In a part of the overlapping portion which is exposed to light from a laser scanning unit (not shown), the developing agent (toner) from the developing roller **32** is formed. The maximum image forming length L_image includes both the length of the image forming area **302** in which the visible image **302***a* is formed, and the length of the test pattern area **304** in which the ACR test patterns **304***a* are formed. Of the maximum image forming length L_image, the length (the length in the primary scanning direction) of the image forming area **302** is determined as the maximum length of the printing medium **306** supported by the image forming apparatus.

To implement both the visible image **302***a* and the ACR test patterns **304***a* and prevent contamination of the transfer roller **65**, the maximum transfer length L_transfer and the maximum image forming length L_image should satisfy the relation of L_transfer<L_image, and the position where the maximum transfer length L_transfer is provided should be set at the location corresponding to the image forming area **302** out of the test pattern forming area **304**. This serves to prevent contamination of the transfer roller **65** by the ACR test pattern **304***a* by limiting the length and position of the image forming area **302** where the visible image **302***a* may be formed, specifically by setting the position at a location out of the test pattern forming area **304** since the maximum transfer length L_transfer is involved in forming the visible image **302***a* in the image forming area **302**. In addition, to print an image on the printing medium **306** with the maximum size supported by the image forming apparatus, the maximum transfer length L_transfer needs to be greater than the length in the primary scanning direction (i.e., the lateral width) L_medium of the printing medium **306**. That is, to prevent contamination of the transfer roller **65** and ensure normal printing, the relation of L_medium<L_transfer<L_image should be satisfied.

As is apparent from the above description, an image forming apparatus having a developing unit, an intermediate transfer body, and a transfer roller according to one or more embodiments may prevent contamination of the transfer roller and the printing medium by the toner remaining in the test pattern forming area of an intermediate transfer body.

Although a few embodiments have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the disclosure, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. An image forming apparatus comprising:

a developing unit to form an electrostatic latent image and allow an image to be formed by a developing agent supplied to the electrostatic latent image;

an intermediate transfer body having an image forming area and a test pattern forming area arranged in parallel in a primary scanning direction, wherein the image is transferred from the developing unit to the image forming area and the test pattern forming area; and

a transfer roller allowing the image transferred to the image forming area of the intermediate transfer body to be transferred to a printing medium,

wherein a maximum transfer length, which is a maximum length of the transfer roller allowing transfer of the image to the printing medium, is less than a maximum image forming length, which is a maximum length of the developing unit allowing the image to be developed,

wherein the transfer roller is positioned so that the maximum transfer length of the transfer roller corresponds to the image forming area of the intermediate transfer body, which is outside of the test pattern forming area of the intermediate transfer body.

2. The image forming apparatus according to claim **1**, wherein:

the developing unit comprises a photosensitive medium, a developing roller, and a charging roller, and

portions of the photosensitive medium, developing roller, and charging roller overlap each other in the primary scanning direction which corresponds to the maximum image forming length.

3. The image forming apparatus according to claim **2**, wherein the maximum image forming length includes a length of the test pattern forming area and a length of the image forming area.

4. The image forming apparatus according to claim **1**, wherein the maximum transfer length of the transfer roller is greater than a length in the primary scanning direction of a printing medium with the largest size supported by the image forming apparatus.

5. The image forming apparatus according to claim **1**, wherein a cleaning unit to clean only a test pattern formed in the test pattern forming area is installed at a position corresponding to the test pattern forming area in the image forming apparatus.

6. The image forming apparatus according to claim **1**, wherein the intermediate transfer body is a transfer belt.

7. The image forming apparatus according to claim **1**, wherein the intermediate transfer body is a transfer drum.

8. An image forming apparatus comprising:

a developing unit to form an electrostatic latent image and allow an image to be formed by a developing agent supplied to the electrostatic latent image;

an intermediate transfer body having an image forming area and two test pattern forming areas arranged at both sides of the image forming area to be parallel with the image forming area in a primary scanning direction, wherein the image is transferred from the developing unit to the image forming area and the two test pattern forming areas, wherein the two test pattern forming areas include a first test pattern forming area formed on one side of the image forming area and a second test pattern forming area formed on the other side of the image forming area; and

a transfer roller allowing the image transferred to the image forming area of the intermediate transfer body to be transferred to a printing medium,

wherein a maximum transfer length, which is a maximum length of the transfer roller allowing transfer of the image to the printing medium is less than a maximum image forming length, which is a maximum length of the developing unit allowing the image to be developed,

wherein the transfer roller is positioned so that the maximum transfer length of the transfer roller corresponds to the image forming area of the intermediate transfer body, which is outside of the two test pattern forming areas of the intermediate transfer body.

9. The image forming apparatus according to claim 8, wherein:

the developing unit comprises a photosensitive medium, a developing roller, and a charging roller, and

portions of the photosensitive medium, developing roller, and charging roller overlap each other in the primary scanning direction which corresponds to the maximum image forming length.

10. The image forming apparatus according to claim 9, wherein the maximum image forming length includes lengths of the two test pattern forming areas and a length of the image forming area.

11. The image forming apparatus according to claim 8, wherein the maximum transfer length of the transfer roller is greater than a length in the primary scanning direction of a printing medium with the largest size supported by the image forming apparatus.

12. The image forming apparatus according to claim 8, wherein two cleaning units to clean only test patterns formed in the two test pattern forming areas are installed at positions corresponding to the two test pattern forming areas in the image forming apparatus.

13. The image forming apparatus according to claim 8, wherein the intermediate transfer body is a transfer belt.

14. The image forming apparatus according to claim 8, wherein the intermediate transfer body is a transfer drum.

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